FLEXIBLE TUBE OF ENDOSCOPE AND ENDOSCOPE

This application is based upon and claims the benefit of priority from the prior Japanese Patent No. 2002-348741 filed on November 29, 2002; the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a flexible tube for an endoscope and an endoscope, which can be subjected to autoclave sterilization (high-temperature and high-pressure steam sterilization).

2. Description of the Related Art

Nowadays, endoscopes are widely used in the medical field. The surgeon can insert a fine and elongated inserting portion of the medical endoscope into the body cavity or the like so as to observe deep portions or the like within the body cavity, and furthermore, so as to perform treatment or the like using a treatment tool as necessary. Note that there is the need to disinfect and sterilize the aforementioned medical endoscopes after use in a sure manner.

As a sterilization method for such medical devices, autoclave sterilization (high-temperature and high-pressure

steam sterilization) is becoming a mainstream method. The autoclave sterilization (high-temperature and high-pressure steam sterilization) has the advantage of the fact that the devices can be used immediately after sterilization without troublesome operation with low running costs.

As an example of such an endoscope which can be subjected to autoclave sterilization, an arrangement has been proposed as disclosed in Japanese Unexamined Patent Application Publication No. 2000-157484, which includes a check valve that is released (opened) at the time of the pressure within the endoscope becoming equal to or greater than a predetermined value, i.e., becoming high, in order to prevent the pressure within the endoscope from becoming relatively higher than the external pressure.

SUMMARY OF THE INVENTION

According to an aspect of the present invention, a flexible tube of an endoscope comprises a mesh tube, which is provided to an inserting portion of the endoscope, formed of at least two metal wires in the shape of a mesh, wound with an angle so that the metal wires are not disposed in the direction orthogonal to or parallel to the longitudinal direction of the inserting portion, and a contracting member for generating the contraction force in the longitudinal direction of the inserting portion generally with the same

magnitude as the extension force in the longitudinal direction of the inserting portion, generated due to the pressure difference between the inside and the outside of the endoscope.

The above and other objects, features and advantages of the invention will become more clearly understood from the following description referring to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an overall configuration diagram which illustrates an endoscope apparatus;

Fig. 2 is an explanatory diagram which shows a flexible tube of an inserting portion of the endoscope shown in Fig. 1;

Fig. 3 is an enlarged explanatory diagram which shows a mesh tube forming the flexible tube shown in Fig. 2; and

Fig. 4 is a conceptual diagram which shows force applied to a conventional flexible tube.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figs. 1 through 3 show an embodiment of the present invention.

As shown in Fig. 1, an endoscope apparatus 1 according to the present embodiment comprises an endoscope 2 including an unshown image pick-up means, a light source device 3,

which is detachably connected to the endoscope 2, for supplying illumination light to a light guide which is inserted into the endoscope 2, a video processor 5, which is connected to the endoscope 2 through a signal cable 4, for controlling the image pick-up means of the endoscope 2, and performing processing for the signals obtained from the image pick-up means so as to output standard format video signals, and a monitor 6 for inputting video signals from the video processor 5 and displaying the endoscope images. Note that the endoscope 2 has a configuration wherein autoclave sterilization (high-temperature and high-pressure steam sterilization) can be performed following washing after use of observation or treatment.

The endoscope 2 principally comprises a fine and elongated and flexible inserting portion 7 and an operating portion 8 included on the base side of the inserting portion 7.

The endoscope 2 includes a flexible universal code 9 extending from the side of the operating portion 8. The universal code 9 includes a connector 10 on the end of the universal code 9, which can be detachably connected to the light source device 3. Furthermore, the connector 10 includes an electric connector 11 on the side thereof. The electric connector 11 is connected to the signal cable 4 which can be connected to the video processor 5.

Furthermore, an inserting-portion bending restriction member 12, an operating-portion bending restriction member 13, and a connector-portion bending restriction member 14, are provided to the connection portion between the inserting portion 7 and the operating portion 8, the connection portion between the operating portion 8 and the universal code 9, and the connection portion between the universal code 9 and the connector 10, respectively, for restricting severe bending of these connection portions.

The inserting portion 7 comprises a flexible tube 15 having flexibility, a bendable curving portion 16 which is provided on the tip side of the flexible tube 15, and a tip portion 17, which is provided to the tip thereof, including an unshown observation optical system, illumination optical system, and the like.

The operating portion 8 includes an air/water supply operating button 21 for operating air supply and water supply, a suctioning operating button 22 for operating suctioning operation, a curving operating knob 23 for operating curving operation for the curving portion 16, multiple remote switches 24 for performing remote control operation of the video processor 5, and a treatment tool inserting opening 25 which is an opening communicating with a treatment tool inserting channel.

The tip portion 17 includes an unshown liquid-supply

opening and air/water supply nozzle for discharging a washing liquid or air toward an unshown observation window according to air/water supply operation, and an unshown suctioning opening, which is an opening on the tip side of the unshown treatment tool cannel, for inserting a treatment tool into the inserting portion 7 or suctioning liquid within the body cavity.

The connector 10 includes an air supply cap 26 which is detachably connected to an unshown air supply source incorporated in the light source device 3, a water-supply tank pressurizing cap 28 and a liquid-supply cap 29, which are detachably connected to a water-supply tank 27 which is a liquid supply source, a suctioning cap 30 which is connected to an unshown suctioning source for performing suctioning through the suctioning opening of the tip portion 17, and a water-supply opening cap 31 which is connected to unshown water-supply means for performing water supply through the liquid-supply opening of the tip portion 17. Furthermore, the connector 10 includes a ground terminal cap 32 for returning leakage current to a high-frequency processing device in the event that high-frequency leakage current occurs in the endoscope at the time of performing high-frequency processing or the like.

The electric connector 11 includes an unshown vent portion for communicating between the inside and the outside

of the endoscope 2. Also, the electric connector 11 can be detachably connected to a waterproof cap 33 with a pressure regulating valve. Note that the waterproof cap 33 includes an unshown pressure regulating valve. The pressure regulating valve has a configuration wherein in the event that the pressure in the inside of the endoscope exceeds a predetermined value as compared with the pressure in the outside thereof, the pressure regulating valve is released so as to maintain the pressure in the inside of the endoscope in the range of the predetermined pressure. With the present embodiment, the pressure regulating valve has a configuration wherein the aforementioned predetermined value can be set so that the force, which extends the flexible tube 15, caused by the difference in the pressure between the inside of the endoscope and the outside thereof in the event that the pressure in the inside of the endoscope is smaller than the pressure in the outside thereof, is generally the same as the force which contracts the flexible tube 15.

Note that the pressure regulating valve according to the present embodiment has a configuration wherein the pressure regulating valve is released in the event that the difference in pressure between the inside and the outside of the endoscope reaches 15 kPa or more.

On the other hand, at the time of autoclave

sterilization, the endoscope 2 is stored in a sterilization storage casing (which will be referred to as "storage casing" hereafter) 34.

The storage casing 34 comprises a tray 35 for storing the endoscope 2, and a back-lid member 36 for the tray 35. The tray 35 and the back-lid member 36 include multiple unshown vents so as to make steam pass through these vents at the time of autoclave sterilization (high-temperature and high-pressure steam sterilization).

The tray 35 includes a fitting portion (not shown) for storing the endoscope 2. The fitting portion is formed in a shape so as to store each component of the endoscope 2 at a predetermined position, and accordingly, upon storing the endoscope in the fitting portion, the endoscope is stored at a predetermined portion. Furthermore, the fitting portion includes an inserting-portion fitting portion (not shown) for storing the inserting portion 7 having flexibility.

Note that for the typical condition for the high-temperature and high pressure steam sterilization, the conditions stipulated by ST37-1992 of the American National Standards Institute and Association for the Advancement of Medical Instrumentation (ANSI/AAMI) are known, wherein in a case of a pre-vacuum type, the sterilization step is performed for four minutes under 132°C, and in a case of a gravity type, the sterilization step is performed for ten

minutes under 132°C.

While the temperature for the sterilization step of the high-temperature and high-pressure steam sterilization is set according to the type of the high-temperature and high-pressure steam sterilization apparatus and the time period of the sterilization step, in general the temperature is set to around in the range of 115°C to 138°C. There are also sterilization apparatuses wherein the temperature for sterilization can be set to around 142°C.

On the other hand, while the time period for the sterilization step is set according to the temperature condition for the sterilization step, in general, the temperature is set in the range of around 3 to 60 minutes. There are sterilization apparatuses wherein the time period for sterilization can be set to around 100 minutes.

In general, the processing is performed in the sterilization chamber under a pressure greater than the atmosphere by around +0.2 MPa.

In general, a pre-vacuum type high-temperature and high-pressure steam sterilization process includes a pre-vacuum step for decompressing the sterilization chamber storing a device which is to be subjected to sterilization prior to a sterilization step, and the sterilization step for performing sterilization by supplying the high-pressure and high temperature steam into the sterilization chamber

following the pre-vacuum step.

The pre-vacuum step is performed for facilitating penetration of steam into the fine structures of the device to be sterilized in the following sterilization step. That is to say, the high-pressure and high-temperature steam reaches all parts of the entire device which is to be subjected to sterilization by decompressing the sterilization chamber. In general, the pre-vacuum step is performed in the sterilization chamber under a pressure less than the atmosphere by around -0.07 MPa to -0.09 Mpa.

Furthermore, a sterilization process is known which includes a dry step for drying the device which is to be subjected to sterilization by decompressing the sterilization chamber again following the sterilization step following the sterilization step. That is to say, in this step, the steam is removed from the sterilization chamber by decompressing the sterilization chamber, thereby prompting drying of the device sterilized in the sterilization chamber. In general, this step is performed in the sterilization chamber under a pressure less than the atmosphere by around -0.07 to -0.09 Mpa.

At the time of performing autoclave sterilization (high-temperature and high-pressure steam sterilization) for the endoscope 2, the processing is performed for the endoscope 2 with the waterproof cap 33, including the

pressure regulating valve, mounted to the electric connector 11. In this state, the unshown pressure regulating valve of the water-proof valve 33 is closed, and accordingly, the vent opening is closed with the water-proof cap 33, whereby the inside of the endoscope 2 is sealed off from the outside in a watertight manner.

In a case of a sterilization method including the pre-vacuum step, upon the pressure difference occurring wherein the pressure in the outside of the endoscope 2 becomes smaller than the pressure in the inside thereof due to reduction of the pressure in the sterilization chamber in the pre-vacuum step, the pressure regulating valve is released (opened) so as to communicate between the inside of the endoscope 2 and the outside thereof through the vent opening, thereby preventing great pressure difference between the inside of the endoscope 2 and the inside of the sterilization chamber. This eliminates the problem that the endoscope 2 might be damaged due to the pressure difference between the inside and the outside of the endoscope 2 in the pre-vacuum step.

In the sterilization step, the inside of the sterilization chamber is pressurized. As a result, upon the pressure difference occurring wherein the pressure in the outside of the endoscope 2 becomes greater than the pressure in the inside thereof, and the pressure regulating valve is

closed. Thus, a great amount of the high-pressure and high-temperature steam does not enter the inside of the endoscope 2 through the water-proof cap 33 and the vent opening.

However, the high-temperature and high-pressure steam gradually penetrates into the inside of the endoscope 2 through the surface of the flexible tube formed of a polymeric material, an O-ring formed of fluororubber or silicone rubber or the like, serving as sealing means provided to the connection portion of the casing of the endoscope 2, and so forth. Note that the endoscope 2 is subjected to the positive pressure from the outside to the inside due to decompressing in the casing in the pre-vacuum step and the pressurizing in the sterilization step.

In a case of a method including a decompressing step after the sterilization step, the pressure in the sterilization chamber is reduced in the decompressing step, whereby the pressure difference occurs wherein the pressure in the outside of the endoscope 2 becomes smaller than the pressure in the inside thereof. In this case, the pressure regulating valve is released (opened) generally at the same time, and accordingly, the insides of the endoscope communicates with the outside thereof through the vent opening, thereby preventing occurrence of greater pressure difference between the inside of the endoscope and the inside of the sterilization chamber. This eliminates the

problem that the endoscope 2 might be damaged due to the pressure difference between the inside and the outside of the endoscope 2 in the decompressing step.

Following the decompressing step, the inside of the sterilization chamber is pressurized. As a result, upon the pressure difference occurs wherein the pressure in the outside of the endoscope becomes greater than the pressure in the inside thereof, the pressure regulating valve provided to the water-proof cap 33 is closed.

As described above, at the time of all the steps for the autoclave sterilization (high-temperature and high-pressure steam sterilization) ending, the endoscope 2 is subjected to the positive pressure from the outside to the inside due to reduction of the pressure in the casing of the endoscope 2 in the decompressing step.

Subsequently, upon the water-proof cap 33 being detached from the electric connector 11, the inside of the endoscope communicates with the outside thereof through the vent opening. As a result, the pressure in the inside of the endoscope becomes the same as the atmosphere, and accordingly, the pressure load on the casing of the endoscope becomes zero.

Next, description will be made regarding the configuration of the flexible tube 15 with reference to Figs. 2 and 3.

As shown in Fig. 2, the flexible tube 15 comprises a spiral tube 37 formed of metal strips wound in a spiral shape, a mesh tube 38 in the shape of a mesh for covering the spiral tube 37, and a covering tube 39, which serves as a contracting member or means for generating contraction force, for covering the outer circumference of the mesh tube 38. The flexible tube 15 is formed of the aforementioned components in that order from the inside thereof.

The mesh tube 38 is formed of at least two metal wires in the shape of a mesh, wound at an angle such that the metal wires are not disposed in the direction orthogonal to or parallel to the longitudinal direction thereof.

In the event that the pressure in the inside of the endoscope becomes smaller than the pressure in the outside thereof, the mesh angle of the mesh tube 38 changes to reduce the volume of the inside of the flexible tube 15, due to the pressure difference between the inside and the outside of the endoscope.

At this time, the mesh tube 38 is subjected to the force causing the metal wires to be moved in the longitudinal direction (the direction wherein the metal wires cross with a small angle). That is to say, the mesh tube 38 reduces the diameter of the flexible tube 15, as well as generating the force F1 causing extension of the entire flexible tube in the longitudinal direction thereof.

Note that the force F1 causing the extension of the flexible tube 15 is generated due to the pressure difference on the entire outer circumference of the flexible tube 15, and accordingly, the force F1 is dependent upon the diameter and the length of the flexible tube 15, even under the same pressure.

The present embodiment has a configuration wherein the flexible tube 15 generates the contraction force in the longitudinal direction thereof against the extension force of the flexible tube 15, generally with the same magnitude as the extension force of the flexible tube 15 in the longitudinal direction thereof, due to contraction of the covering tube 39 of the flexible tube 15, thereby suppressing the change in the length of the flexible tube 15.

That is to say, the covering tube 39 according to the present embodiment is formed of a blend of styrene resin and ester resin, which are polymeric materials, with a ratio of 1 to 2, for example. Note that an arrangement may be made wherein the covering tube 39 is formed of a blend of olefin resin and amide resin, for example. The covering tube 39 is formed with a tube thickness according to the design of the flexible tube 15. For example, the flexible tube 15 according to the present embodiment is formed with a length of 1600 mm, and an outer diameter of 12.9 mm, and the covering tube 39 is formed with a tube thickness of 0.2 mm

so as to cover the mesh tube 38.

As described above, the covering tube 39 is formed of a blend of styrene resin and ester resin, and accordingly, the covering tube 39 generates the force F2 causing contraction at the time of heating in the autoclave sterilization. The contraction force F2 is determined depending upon the thermal contraction coefficients of the materials forming the covering tube 39, the blend ratio thereof, the outer diameter of the flexible tube 15, and the tube thickness of the covering tube 39.

The covering tube 39 is formed so as to generate the force generally matching the force F1 causing extension of the flexible tube 15.

The endoscope 2 including the flexible tube 15 having such a configuration is subjected to washing and disinfecting following endoscope examination. Following the washing and disinfecting, the endoscope 2 is stored in the storage case 34 and stored in the autoclave sterilization apparatus along with the storage case 34, and is subjected to the above-described autoclave sterilization (high-temperature and high-pressure steam sterilization).

Let us say that the endoscope 2 includes the flexible tube 15 formed with a length of 1600 mm, an outer diameter of 12.9 mm, and a tube-thickness of the covering tube 39 of 0.2 mm, as described above. Furthermore, let us say that

the pressure regulating valve provided to the water-proof cap 33 is set so as to be released at the time of the pressure difference reaching 15 kPa or more.

Furthermore, let us say that each step of the autoclave sterilization process is performed with the autoclave sterilization apparatus under the following pressure, for example.

Pre-vacuum step: performed under a pressure less than the atmosphere by 76 kPa.

Sterilization step: performed under a pressure greater than the atmosphere by 216 kPa.

As described above, following all the steps for the autoclave sterilization (high-temperature and high pressure steam sterilization) being completed, the flexible tube 15, which is a casing member of the endoscope 2, is subjected to the positive pressure from the outside to the inside thereof due to reduction of the pressure in the pre-vacuum step and the increasing pressure in the sterilization step.

Accordingly, a pressure difference of 277 kPa occurs between the inside and outside of the endoscope 2 during the sterilization step, according to the pressure settings for the above-described autoclave apparatus and the settings for releasing pressure with the pressure regulating valve.

As described above, the pressure of 277 kPa occurs, which causes the mesh angle of the mesh tube 38 to be

changed and the volume of the inside thereof to be reduced, and accordingly, the mesh tube 38 generates the force F1 causing the diameter of the flexible tube 15 to be reduced and causing extension of the entire flexible tube 15 in the longitudinal direction.

On the other hand, as described above, the covering tube 39 of the flexible tube 15 is formed of a blend of styrene resin and ester resin, and accordingly, the contraction force F2 occurs due to heating in the autoclave sterilization, thereby generating the force F2 generally matches the force F1 causing extension of the flexible tube 15 on the circumference where the covering tube 39 is in contact with the mesh tube 38.

That is to say, the force F1 causing extension of the flexible tube 15 is generally cancelled out by the force F2 causing contraction of the flexible tube 15, thereby suppressing the change in the length of the flexible tube 15 of the endoscope 2 to within ±5% when performing autoclave sterilization.

Thus, with the endoscope 2 according to the present embodiment, the change in the length of the flexible tube 15 due to the autoclave sterilization can be suppressed to within 5%.

Accordingly, if the change in the length of the flexible tube 15 is suppressed to within 5%, the endoscope 2

can prevent the length of incorporated member from becoming short and also can prevent user's wrong recognition of the inserting length.

Having described the preferred embodiments of the invention referring to the accompanying drawings, it should be understood that the present invention is not limited to those precise embodiments and various changes and modifications thereof could be made by one skilled in the art without departing from the spirit or scope of the invention as defined in the appended claims.